WHAT IS CLAIMED IS:

1. A compact fuel processor for converting a hydrocarbon fuel feed into hydrogen rich gas, comprising a processor assembly containing multiple concentric vessels for converting the hydrocarbon fuel feed into the hydrogen rich gas, wherein the hydrogen rich gas is suitable for direct feed to a fuel cell.

2. The compact fuel processor of claim 1, wherein the processor assembly comprises:

an oxidation core vessel containing an oxidation catalyst;

a reforming vessel surrounding the oxidation core vessel and forming a first annular space filled with autothermal reforming catalyst;

a desulfurizing vessel surrounding the reforming vessel and forming a second annular space filled with desulfurization catalyst;

a shift vessel surrounding the desulfurizing vessel and forming a third annular space filled with water gas shift catalyst; and

a preferred oxidation vessel surrounding the shift vessel and forming a fourth annular space filled with preferred oxidation catalyst.

3. The compact fuel processor of claim 2, wherein the oxidation core vessel oxidizes fuel cell anode tail gas to produce a hot exhaust gas.

4. The compact fuel processor of claim 3, wherein the hot exhaust gas preheats the hydrocarbon fuel.

5. The compact fuel processor of claim 2, further comprising an electric heater for preheating the anode tail gas prior to introducing the anode tail gas to the oxidation core vessel.

6. The compact fuel processor of claim 2, further comprising a second desulfurizing vessel external to the processor assembly for desulfurizing the hydrocarbon fuel feed.

7. The compact fuel processor of claim 6, wherein the second desulfurizing vessel is a replaceable canister.

8. The compact fuel processor of claim 4, wherein the hydrocarbon fuel feed is sequentially introduced to the first annular space, then to the second annular space, then to the third annular space, and then to the fourth annular space to produce the hydrogen rich gas.

9. The compact fuel processor of claim 8, further comprising a plurality of cooling coils for removing the heat of reaction produced in the first annular space, the second annular space, the third annular space, and the fourth annular space.

10. The compact fuel processor of claim 9, wherein a circulating coolant flows through the cooling coils.

11. The compact fuel processor of claim 10, wherein the circulating coolant is selected from a group consisting of air, water, and the hydrocarbon fuel feed.

12. The compact fuel processor of claim 2, wherein the each annular space is surrounded by heat resisting refractory.

13. A compact fuel processor for converting a hydrocarbon fuel feed into hydrogen rich gas, comprising:

a reforming module for converting the hydrocarbon fuel feed into the hydrogen rich gas, wherein the hydrogen rich gas is suitable for direct feed to a fuel cell; and

an oxidizing module for oxidizing fuel cell anode tail gas to produce a hot exhaust gas, wherein the hot exhaust preheats the hydrocarbon fuel feed to the reforming module.

14. The compact fuel processor of claim 13, wherein the oxidizing module comprises:

a first heat exchanger core;

an oxidation core vessel containing an oxidation catalyst; and

a first desulfurizing vessel surrounding the oxidation core vessel and forming a first annular space filled with desulfurization catalyst; and

wherein the oxidation core vessel oxidizes the fuel cell anode tail gas to produce a hot exhaust gas; and

wherein the hydrocarbon fuel feed is preheated by the hot exhaust gas in the first heat exchanger coil to produce a preheated hydrocarbon fuel feed; and

wherein the preheated hydrocarbon fuel feed is desulfurized in the first annular space to create a desulfurized hydrocarbon fuel feed.

15. The compact fuel processor of claim 14, wherein the oxidation core vessel has a first set of external vertical fins for further preheating the preheated hydrocarbon fuel feed to produce a second preheated hydrocarbon fuel feed, and wherein the second preheated hydrocarbon fuel feed becomes the hydrocarbon fuel feed introduced to the first annular space.

16. The compact fuel processor of claim 13, wherein the reforming module comprises:

a second heat exchanger coil;

a reforming core vessel containing an autothermal reforming catalyst bed;

a second desulfurizing vessel surrounding the reforming core vessel and forming a second annular space filled with desulfurization catalyst;

a shift vessel surrounding the second desulfurizing vessel and forming a third annular space filled with water gas shift catalyst; and

a preferred oxidation vessel surrounding the shift vessel and forming a fourth annular space filled with preferred oxidation catalyst; and

wherein the hydrocarbon fuel feed is preheated by the hydrogen rich gas in the second heat exchanger coil to produce a third preheated hydrocarbon fuel feed; and

wherein the third preheated hydrocarbon fuel feed is sequentially introduced to the reforming core vessel, then to the second annular space, then to the third annular space, and then to the fourth annular space to produce the hydrogen rich gas.

17. The compact fuel processor of claim 16, wherein the hydrocarbon fuel feed is a desulfurized hydrocarbon fuel feed.

18. The compact fuel processor of claim 16, wherein the reforming core vessel has a second set of external vertical fins for further preheating the third preheated hydrocarbon fuel feed to produce a fourth preheated hydrocarbon fuel feed, and wherein the fourth preheated hydrocarbon fuel feed becomes the hydrocarbon fuel feed introduced to the reforming core vessel.

19. The compact fuel processor of claim 16, wherein the third annular space has a third heat exchanger coil for reaction temperature control.

20. The compact fuel processor of claim 16, further comprising an electrical heater for starting up the autothermal reforming catalyst bed.

21. A compact fuel processor for converting a hydrocarbon fuel feed into hydrogen rich gas, comprising:

a heat exchanger coil;

a reforming core vessel containing an autothermal reforming catalyst bed;

a desulfurizing vessel surrounding the reforming core vessel and forming a first annular space filled with desulfurization catalyst;

a shift vessel surrounding the desulfurizing vessel and forming a second annular space filled with water gas shift catalyst; and

a preferred oxidation vessel surrounding the shift vessel and forming a third annular space filled with preferred oxidation catalyst; and

wherein the hydrocarbon fuel feed is preheated by the hydrogen rich gas in the heat exchanger coil to produce a preheated hydrocarbon fuel feed; and

wherein the preheated hydrocarbon fuel feed is sequentially introduced to the reforming core vessel, then to the second annular space, then to the third annular space, and then to the fourth annular space to produce the hydrogen rich gas.